

MODIFIABLE RISK FACTORS FOR AGE-RELATED HEARING LOSS IN OLDER ADULTS

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Abstract. Age-related hearing loss is a common progressive sensory disorder among older adults and is influenced by both non-modifiable and modifiable factors. Although biological ageing and genetic predisposition cannot be prevented, several environmental, lifestyle, metabolic, and medical factors may contribute to the onset and progression of auditory decline. This article examines the major modifiable risk factors associated with age-related hearing loss in older adults and discusses their potential importance in prevention. Particular attention is given to prolonged noise exposure, smoking, diabetes mellitus, arterial hypertension, cardiovascular disorders, obesity, physical inactivity, and the use of potentially ototoxic medications. The interaction between these factors and age-related changes in the auditory system may accelerate hearing deterioration and increase the risk of clinically significant hearing impairment. Identification of modifiable risk factors during routine clinical assessment may therefore help distinguish individuals who require closer audiological monitoring and preventive interventions. Strategies aimed at controlling chronic diseases, reducing exposure to excessive noise, promoting healthy lifestyle behaviours, and ensuring careful use of ototoxic medications may contribute to the preservation of hearing function in older adults. A preventive approach based on early risk assessment and regular hearing evaluation may reduce the functional and social consequences of age-related hearing loss.

Keywords. age-related hearing loss, presbycusis, older adults, modifiable risk factors, hearing loss prevention, noise exposure, cardiovascular risk, metabolic disorders.

Introduction

Age-related hearing loss (ARHL), also known as presbycusis, is a progressive sensorineural hearing disorder and one of the most common health problems affecting older adults. Its prevalence increases substantially with advancing age and represents a growing public health concern in ageing populations. According to the World Health Organization, more than 25% of people over 60 years of age experience disabling hearing loss. Unaddressed hearing impairment may interfere with effective communication, social participation, independence, and quality of life and has also been associated with social isolation and adverse cognitive outcomes [1].

Although ageing is the principal factor underlying ARHL, the development and severity of hearing impairment vary considerably among individuals of similar age. This variability indicates that presbycusis cannot be explained solely by chronological ageing. Current evidence supports a multifactorial model in which age-related degeneration of the auditory system interacts with genetic susceptibility, environmental exposures,

lifestyle behaviours, chronic diseases, and medication-related factors. A systematic review of epidemiological evidence identified occupational noise exposure, ototoxicity, lifestyle-related factors, underlying health conditions, and age progression among the major factors associated with adult-onset hearing loss [2].

From a preventive perspective, it is particularly important to distinguish between non-modifiable and modifiable risk factors. Age, genetic predisposition, and some biological characteristics cannot be altered. In contrast, a number of environmental and behavioural exposures and chronic health conditions may potentially be prevented, reduced, or controlled. These include prolonged exposure to excessive noise, cigarette smoking, physical inactivity, unhealthy dietary patterns, obesity, diabetes mellitus, hypertension, cardiovascular disorders, and exposure to potentially ototoxic substances or medications. Recent literature on ARHL has highlighted these lifestyle and environmental factors as potentially relevant targets for hearing-loss prevention because several of them may contribute to oxidative stress, vascular dysfunction, inflammation, and damage to auditory structures [3].

The interaction between modifiable and non-modifiable factors is also clinically significant. Genetic susceptibility does not necessarily determine hearing outcomes independently of lifestyle. A large biobank-based study demonstrated a joint association between genetic risk and lifestyle factors in the development of ARHL and found that healthier lifestyle patterns were associated with a lower risk of age-related hearing impairment even among individuals with higher genetic susceptibility [4]. These findings reinforce the importance of considering hearing health within a broader preventive framework rather than regarding auditory decline as an unavoidable consequence of ageing.

Recognition of modifiable risk factors is therefore relevant not only for understanding the pathogenesis of ARHL but also for identifying individuals who may benefit from closer audiological surveillance and preventive counselling. Measures such as reducing harmful noise exposure, smoking cessation, appropriate management of hypertension and diabetes, maintenance of regular physical activity and healthy nutrition, and rational use of potentially ototoxic medications may contribute to protecting hearing throughout the life course. WHO also emphasizes protection from excessive noise, healthy lifestyle practices, avoidance of smoking, and prevention or appropriate management of chronic diseases as important measures that may help prevent or delay hearing deterioration in older age [1].

Therefore, greater attention to potentially modifiable determinants of hearing loss may provide an opportunity to complement conventional audiological management with preventive strategies. The aim of this article is to analyse the principal modifiable risk factors associated with age-related hearing loss in older adults and to discuss their clinical relevance for the prevention or delay of progressive auditory decline.

Noise Exposure and Ototoxic Medications. Long-term exposure to excessive noise is one of the most important potentially modifiable environmental factors associated with hearing loss. Occupational noise from industrial machinery, construction, transportation,

and other high-intensity sources may result in cumulative damage to cochlear structures. Recreational exposure to loud music and amplified sound may further increase the lifetime auditory burden. Although age-related and noise-induced hearing loss are distinct conditions, repeated noise exposure throughout life may interact with age-related degeneration and contribute to greater auditory impairment in later years. A recent systematic review of adult-onset hearing loss identified occupational noise exposure as one of the major epidemiological risk-factor domains relevant to hearing deterioration [2].

Noise-related damage predominantly affects cochlear sensory structures and may initially involve high-frequency hearing. The cumulative nature of such injury is particularly important in older adults because previous environmental exposure may become clinically apparent as the auditory system loses physiological reserve with ageing. Therefore, obtaining a detailed history of occupational and recreational noise exposure should form part of the clinical assessment of older patients with suspected hearing impairment. Preventive measures include reducing unnecessary exposure to loud sounds, using appropriate hearing protection in high-noise environments, and promoting safe listening practices throughout the life course.

Exposure to ototoxic medications represents another potentially modifiable contributor to hearing deterioration. Drugs with recognized ototoxic potential include aminoglycoside antibiotics, platinum-based chemotherapeutic agents, loop diuretics, and several other medication groups. Aminoglycosides and platinum compounds such as cisplatin may damage cochlear hair cells and can result in permanent sensorineural hearing loss [5].

The relevance of medication exposure is particularly high in older patients because multimorbidity frequently results in the simultaneous or sequential use of several medications. A longitudinal population-based study involving 3,753 participants found that a greater number of ototoxic medications was associated with an increased risk of incident hearing loss over a 10-year period. In the same study, loop diuretics were associated with incident hearing loss, while nonsteroidal anti-inflammatory drugs and loop diuretics were associated with progression of hearing impairment [6].

These findings do not imply that medically necessary medications should be discontinued solely because of potential ototoxicity. In many circumstances, the therapeutic benefits of antibiotics, chemotherapy, or other essential drugs clearly outweigh auditory risks. The clinically appropriate strategy is therefore careful risk assessment, rational prescribing, and audiological monitoring in susceptible individuals, particularly when high-risk medications are used repeatedly or for prolonged periods.

Smoking and Lifestyle-Related Factors. Lifestyle behaviours may influence the development and progression of hearing impairment through vascular, metabolic, and inflammatory mechanisms. Cigarette smoking has repeatedly been associated with hearing loss in epidemiological studies. Tobacco exposure may adversely affect cochlear function by contributing to vascular dysfunction, oxidative stress, and reduced oxygen supply to metabolically active auditory structures. A recent systematic review and meta-

analysis of hearing loss in adults identified both current and past smoking among factors associated with an increased risk of hearing impairment [7].

The importance of lifestyle factors extends beyond smoking. Physical activity, body weight, dietary habits, alcohol consumption, sleep, and environmental exposures may act together rather than independently. This concept is supported by large population-based data. In a 2024 study using the UK Biobank and Penn Medicine Biobank, poor lifestyle patterns were associated with substantially greater odds of age-related hearing loss. Importantly, adherence to a healthier lifestyle was associated with lower ARHL risk even among individuals with high genetic susceptibility [4].

These findings are clinically important because they challenge the assumption that hearing deterioration in later life is determined exclusively by ageing and heredity. Genetic susceptibility cannot be modified, but behavioural and environmental factors can often be addressed. Smoking cessation, regular physical activity, maintenance of healthy body weight, balanced nutrition, and reduction of harmful environmental exposures may therefore form part of a broader strategy for preserving auditory health. However, such measures should be viewed as risk-reduction strategies rather than as guaranteed methods of preventing presbycusis.

Cardiovascular and Metabolic Risk Factors. The cochlea depends on an adequate and stable blood supply, and age-related changes in the microvascular system may increase its vulnerability to systemic vascular and metabolic disorders. For this reason, diabetes mellitus, hypertension, obesity, dyslipidaemia, and cardiovascular disease have received considerable attention as potentially modifiable factors associated with hearing loss.

Diabetes mellitus is one of the most consistently reported metabolic conditions associated with auditory impairment. Chronic hyperglycaemia may contribute to microangiopathic changes, oxidative stress, and neural dysfunction, potentially affecting both peripheral and central components of the auditory system. A systematic review and meta-analysis examining metabolic conditions reported increased odds of hearing loss among individuals with diabetes, obesity, hypertension, and metabolic syndrome [8].

Cardiovascular factors are also relevant, although the strength of evidence differs between individual conditions. Analysis from the Canadian Longitudinal Study on Aging found associations between diabetes, obesity, hypertension, smoking, and poorer audiometric hearing, with combinations of cardiovascular risk factors associated with greater hearing-loss risk [9]. A systematic review of cardiovascular diseases and sensorineural hearing loss similarly found consistent associations with coronary artery disease and diabetes, whereas associations with hypertension and hyperlipidaemia were less consistent across studies [10].

This distinction is important. It would be scientifically inaccurate to state that hypertension or dyslipidaemia directly causes age-related hearing loss. Available evidence primarily demonstrates associations, and many studies are observational. Age, medication use, smoking, socioeconomic factors, and other chronic conditions may also influence the observed relationships. Nevertheless, appropriate management of diabetes,

hypertension, obesity, and cardiovascular disease remains clinically justified for general health and may simultaneously reduce potentially harmful influences on auditory function.

Preventive Implications of Modifiable Risk Factors. Recognition of modifiable risk factors provides an opportunity to shift the clinical approach to age-related hearing loss from management of established impairment toward earlier risk reduction. Preventive assessment should therefore consider not only the patient's current hearing thresholds but also lifetime noise exposure, smoking history, metabolic and cardiovascular status, medication use, and other relevant lifestyle factors.

A practical preventive strategy may combine regular hearing assessment with control of modifiable exposures. Individuals with a history of occupational noise, diabetes, cardiovascular disease, smoking, or repeated exposure to potentially ototoxic medications may benefit from closer audiological surveillance. The presence of multiple risk factors may be particularly important because their effects can accumulate and interact with biological ageing. Contemporary epidemiological evidence increasingly supports this multifactorial interpretation of adult-onset hearing loss [2,4].

Prevention should therefore include education on safe listening and occupational hearing protection, smoking cessation, promotion of physical activity and healthy weight, adequate management of metabolic and cardiovascular disorders, and careful monitoring when ototoxic treatment is clinically necessary. At the same time, the available evidence does not support presenting age-related hearing loss as completely preventable. Biological ageing and genetic susceptibility remain important determinants. The realistic objective is to reduce avoidable auditory damage, delay the progression of hearing deterioration where possible, and identify high-risk individuals before substantial functional impairment develops.

Thus, modifiable risk-factor assessment should be regarded as a complementary component of hearing care in older adults. Combining risk reduction with periodic audiological evaluation may provide a more comprehensive approach to preserving hearing function and reducing the consequences of age-related auditory decline.

Conclusion

Age-related hearing loss is a multifactorial condition in which biological ageing and genetic susceptibility interact with environmental, lifestyle, metabolic, and medical factors. Although ageing itself cannot be modified, several factors associated with auditory deterioration can potentially be reduced or controlled. Long-term exposure to excessive noise, smoking, ototoxic medications, diabetes mellitus, obesity, hypertension, cardiovascular risk factors, and unhealthy lifestyle patterns should therefore receive greater attention in the assessment of older adults.

Identification of these modifiable factors may help determine individuals who require closer audiological monitoring and targeted preventive counselling. Measures such as protection from excessive noise, smoking cessation, maintenance of a healthy lifestyle, appropriate management of metabolic and cardiovascular diseases, and careful use of potentially ototoxic medications may contribute to reducing additional auditory

damage. However, current evidence is predominantly based on observational associations, and these measures should not be regarded as guaranteed methods for preventing presbycusis.

A comprehensive approach combining modification of avoidable risk factors with regular hearing assessment may provide a practical strategy for preserving auditory function and detecting progressive hearing deterioration at an earlier stage. Further longitudinal and interventional studies are required to determine the extent to which modification of individual risk factors can prevent or delay age-related hearing loss.

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